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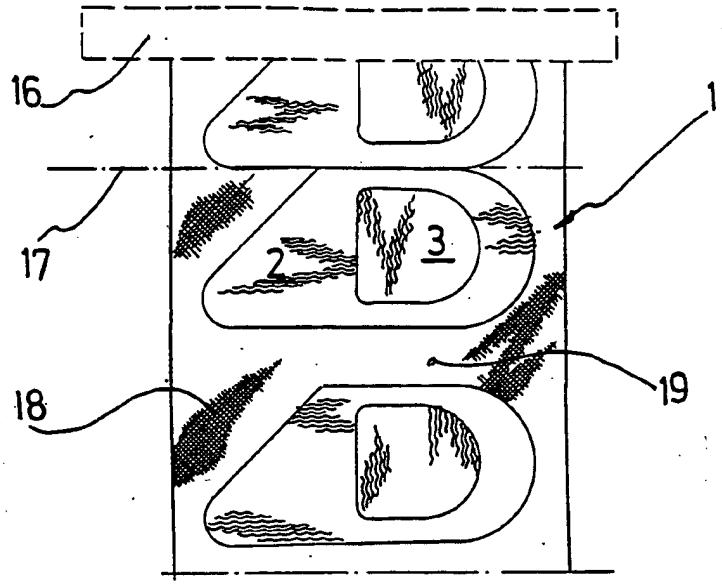

(57) Abstract

The invention relates to a heterogeneous custom made knitted fabric (1) in which metal fibers are incorporated into predetermined zones (2-15) with differing knitting patterns.

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HETEROGENOUS KNITTED FABRIC COMPRISING METAL FIBERS

The invention relates to a heterogenous custom made knitted fabric comprising metal fibers.

In the field of so-called technical textile fabrics there is an ever increasing demand for the custom production of heterogenous knitted fabrics for diverse purposes and applications, that contain metal fibers and in which predetermined zones or areas having different knitting patterns are present over their surface and/or through their thickness. The expression "knitted fabric containing zones having different knitting patterns" is to be understood here as knitted fabric in which the knitted structure, in particular zones, differs from the bordering zones by differences in mesh size, mesh form, stitch pattern, mesh connection, fiber and/or yarn composition, fiber and/or yarn structure and/or thickness of the knitted structure. As a result of these structural differences, therefore, the appearance, feel, touch or drape, fabric density (air permeability) or stretchability in one or another direction and either the strength or resistance to wear, the transverse compressibility (perpendicular to the surface of the fabric) and the (bending) stiffness will also differ locally in relation to the bordering zones. The manufacture of heterogeneous knitted fabrics out of non-metallic fibers on flat knitting machines is already known from the magazine "Wirkerei- und Strickereitechnik", 1991, No. 2 (pages 133-138).

The necessity of providing metal fibers locally in the fabric can be related to the need for local zones in the fabric with a predetermined electrical or heat conductivity, heat resistance, wear resistance or durability, strength, etc., whether or not linked to a pre-determined flexibility, structural density and/or elasticity. Before the knitting process, the metal fibers will be

processed into - or incorporated into - yarns that, for example, can be used on flat knitting machines. The suitable metal fibers according to the invention, therefore, have a diameter of between approximately 2 μm and 30 μm. They can be produced by a method of bundled drawing as is known, for example, from U.S. patents No. 2.050.289 or No. 3.379.000. Subsequently, they can be spun into multifilament or staple fiber yarns (whether or not doubled) with a metric number between 5 and 60 for use in the later knitting process. If so desired, the metal fibers can be mixed beforehand with a particular ratio of other fibers such as cotton, wool, fiber glass, carbon fibers, ceramic or synthetic fibers in order to incorporate one or another mixed yarn composition in one or another knitted fabric zone or area. The synthetic fibers can be aramide fibers, or they can also be thermoplastic fibers having, for example, a relatively low melting point. Long metal fibers, obtained by a shaving process as described in EP 319.959 can be used as well.

The invention will now be explained by means of a number of embodiments and possible applications, with reference to the accompanying figures.

Figure 1 shows consecutive custom knitted fabric sections, such as those produced by a flat knitting machine, in the surface of which there are zones that have differing knitting patterns.

Figure 2 is a sketch of a double-layered knitted structure with different knitting patterns over their surfaces.

Figure 3 represents a knitted fabric with some border zones having different knitting patterns.

Figure 4 represents a knitted fabric with a local double-knitted zone which is not totally attached to the base layer.

Figure 5 illustrates a local knitted zone with pile loops.
Figure 6 shows a stitch pattern with additional weft threads.
Figure 7 relates to a knitted structure with local ribs.
Figure 8 schematically represents a knitted fabric with locally thinner zones in the form of grooves.
Figure 9 shows a knitted structure with local three-dimensional patterns in relief.
Figure 10 illustrates the use of a heterogeneous knitted structure as cover for a conveyor and
Figure 11 is a representation of the use of a knitted interlayer in a welding process.

The sections of knitted fabric shown in Figure 1, which are consecutively produced by the flat knitting machine 16, contain zones or areas 2 and 3 in their surface; these zones have different knitting patterns. A separation thread 17 runs between the edges of the consecutive sections; this thread can easily be pulled out in order to separate the custom knitted sections from one another for use.

Another option is to surround the consecutive knitted sections 1 during the knitting process with a border zone 18 made of, for example, inexpensive fiber yarns in order to be able to produce simple connecting borders or knitted transition areas between the consecutive sections. Intermediate borders 19 can thus also be produced out of these inexpensive yarns; the knitted fabric is then cut along these borders for the purpose of separating the sections 1 one by one.

Metal fiber yarns are incorporated into at least one of the zones, e.g. in the central zones 3 or in the border zones 2, or in both. The metal fiber concentration can then differ from one predetermined zone to another. In certain cases all yarns in at least one

zone can consist of 100 % metal fiber, e.g. stainless steel fiber. If the yarns containing metal fiber are mixed yarns containing other fibers, then they will comprise preferably at least 20 % metal fibers. In particular zones, of course, yarns not containing metal fiber can be knit together with yarns containing metal fibers.

The double-layered knitted fabric according to Figure 2 can include yarns containing metal fiber in one or in both of its surfaces. Both layers - underlayer 4 and upper layer - are joined to each another in one or another known manner with binding threads. Moreover, (locally) distinct surface patterns 2, 3 or embossed areas can be present in one or in both layers. If so desired, one or both layers may consist entirely of metal fiber yarns (100 % metal). The fabrics can be calendered to adjust their density (air permeability).

For a number of applications it will be desirable and sufficient to incorporate metal fibers only in a number of border zones 5, 6, as shown in Figure 3. Moreover, the stitch patterns or constructions of different parts of the border zones 5 and 6 can differ from one another or from the construction in the central zone 7. Conversely, it is also possible to use only metal fibers in a central area 7.

The flat knitting methods as, for example, utilized with the CMS machines of Stoll G.m.b.H. in Reutlingen, also make it possible to produce knitted fabrics as represented in Figure 4 that have a base layer 8 with double-layered subsections 9 locally distributed over its surface, in which the subsections are attached to the base layer only near a number of their edges 10.

It is also possible to knit loop pile zones 11 containing metal fiber into at least a part of one or both sides of a knitted fabric as indicated in Figure 5.

The knitting of additional weft yarns 20 into the fabric, as shown in Figure 6, can be useful in cases where one wants to limit the extensibility of this weft direction. The metal fibers can be incorporated into these yarns 20, as well as into the yarns 21 of the base layer.

The flat knitted fabric can contain relatively thick zones 12 beside relatively thin ones. As represented in Figure 7, the thicker zones can have the form of ribs. By way of contrast, a configuration with relatively thin zones 13 can be made, e.g. in the form of grooves. The thicker zones lying between the grooves then can give the whole a wafer look.

The dimensions of the little wafers can be limited so that a relief pattern is created out of pyramid-like projections.

Finally, a three-dimensional knitted fabric can be designed and produced which contains a sack form 14 or a box form 15, as shown in Figure 9. These three-dimensional forms or shapes can in turn be worked or incorporated with their edges into sections 22 of flat knitted fabric. The sack form can be produced in the shape of a half sphere.

Example

A knitted fabric made of stainless steel fibers (type 316L) with a diameter of 12 µm and fabricated by means of bundled drawing as described above, is fabricated at a pitch of 12 gauges on a CMS 440 flat knitting machine made by Stoll G.m.b.H. in Reutlingen. The geometric form of the fabric resembles that of the sections 1

shown in Figure 1. The outside edge 18 and the intermediate strip 19 around the sections are made of cotton. In zone 2 a knitted fabric is utilized, made of the steel yarn 316L with a metric number of 2 x 11/2. The stitch pattern is 1/2, the column spacing 1.73 mm, the row spacing 1.48 mm, the thickness 1.5 mm and the resulting weight 1327 g/m^2. This results in an air permeability of 6200 l/h at a pressure gradient of 100 Pa over the fabric. A 316L yarn with Nm 11/2 made of 8 μm diameter fibers is knitted at a pitch of 12 gauges in the central zone 3 with a stitch pattern of 1/3 and three accompanying filler threads per row. Section 3 has a thickness of 1.85 mm, a weight of 1885 g/m^2 and an air permeability of 1800 l/h.

The flat knitted heterogeneous fabrics which contain metal fibers are useful in particular as liner or covering for a carrier which has to support objects at a temperature substantially different from that of the carrier. The so covered carrier has indeed to resist effectively thermal shocks under different circumstances of operation. Or otherwise the thus covered carrier has to prevent that thermal shocks occur at the first moment of contact between carrier and object to be carried when said object and carrier have a substantially different temperature. This resistance against thermal shocks should furthermore often be combined with an adjustable balance between intrinsic thermal conductivity of the fabric (for heat transmission) and the desired insulation capacity of the different fabric sections. Furthermore the fabric should sometimes satisfy a certain need for a mechanical cushioning capacity (elastic compressibility, vibration damping, porosity) and a certain minimum wear resistance. The thermal conductivity, measured according to the standard NBN-B 62-201 (with guard heater) should range between 0,05 and 0,1 Watt/m/K.

For transporting freshly formed objects which are still hot, such as thin-walled glass or ceramic objects, a fabric according to the invention has been used for lining or covering the chain links of a conveyor.

Figure 10 shows the successive links 23 of the conveyor. Strips 25, consisting of flat knitted metal fiber fabrics are fixed to the top surface 24 of the links 23 by means of their edges 26, e.g. by welding.

The knitted structure 1 comprises successive parallel metal fiber strips 25 which are knitted to each other by means of strips 27 comprising e.g. textile fibers. This occurs in one knitting operation on a flat knitting machine CMS 440. The edges 26 are thinner than the cushion forming central part 28. This part 28 is intended to prevent thermal shocks in the object when it comes into contact with the conveyor.

The intermediate strips 27 may consist of synthetic textile yarns or cotton. They only serve as a knitted joint and are cut away to separate the strips 25 for fixation one by one on the top surfaces 24 of the links 23.

The flat knitting method for the heterogeneous fabric thus allows an easy process for joining the strips 25. The yarns of strips 25 were spun metal fiber yarns (Nm 11/2) from Bekinox 316L-fibers with a diameter of 12 μm. The fabric was double layer knit in strips 28 and single layer in the edges 26 and in joints 27 on a CMS 440. The strips 25 had a thickness of 4,2 mm. Suitable permeabilities range between 1000 and 2000 l/h/10 cm^2 with a pressure drop of 100 Pa.

With the embodiment of figure 11, two relatively thin plates of stainless steel 31 and 32 can be joined by welding by interposition of (a thicker) aluminium plate 33. The earthed electrode 30 is therefor covered with a heterogeneous double layer knit metal fiber fabric 29. This fabric, knit on a CMS 440 can consist of an outer layer from Inconel 601 fibers in contact with plate 32 and an inner layer with larger meshes from 316L fibers contacting electrode 30. The welding pressure exerted by electrode 34 can reach 10 MPa or even more. The fabric 29 had a thickness (non compressed) of 1,8 mm and a weight of 3,15 kg/m^2.

CLAIMS

1. Heterogeneous custom knitted fabric (1) comprising yarns which contain metal fiber with a fiber diameter of between 2 and 30 μm and predetermined zones or areas (2 - 15) with a different knitting pattern.

2. Knitted fabric according to claim 1 in which the different knitting pattern is present in predetermined surface zones (2 - 7).

3. Knitted fabric according to claim 1 or 2 in which the different knitting patterns are present in predetermined zones (9 - 11) through the thickness of the knitted fabric.

4. Knitted fabric according to claim 2 with a predetermined outer periphery and in which only a number of border zones (5, 6, 8) include yarns containing metal fibers.

5. Knitted fabric according to claim 2 with predetermined outer periphery and in which only a number of central zones (3, 7, 9, 11 - 15) include yarns containing metal fiber.

6. Double-layered knitted fabric according to claim 3 in which only one layer (4) includes yarns containing metal fiber and in which the two layers are joined to one another with binding threads.

7. Knitted fabric according to claim 1 including a base layer (8) and double-layered subsections (9) over its surface in which the subsections are attached to the base layer only near a number of their edges (10).

8. Knitted fabric according to claim 1 in which the metal fiber concentration differs from one predetermined zone to another.

9. Knitted fabric according to claim 2 comprising loop pile zones (11) over at least one surface of the fabric.

10. Knitted fabric according to claim 1 comprising additional weft threads (20).

11. Flat knitted fabric according to claim 2 comprising relatively thick (12) and relatively thinner zones.

12. Knitted fabric according to claim 11 comprising relatively thicker zones in the form of ribs (12).

13. Knitted fabric according to claim 11 comprising relatively thinner zones in the form of grooves (13).

14. Knitted fabric according to claim 1 in which the yarns containing metal fibers have a metal fiber composition of at least 20 % by volume.

15. Knitted fabric according to claim 14 in which the yarns consist of 100 % metal fiber.

16. Knitted fabric according to claim 15 in which all the yarns consist of 100 % metal fiber.

17. Three-dimensional knitted fabric according to claim 1 including a sack or box form.

18. Knitted fabric according to claim 17 in which the sack form comprises a half sphere.

19. Knitted fabric according to claim 17 comprising a relief pattern of sack-forming sections (13, 14) which are interconnected by means of their edges to flat knitted fabric sections (22).

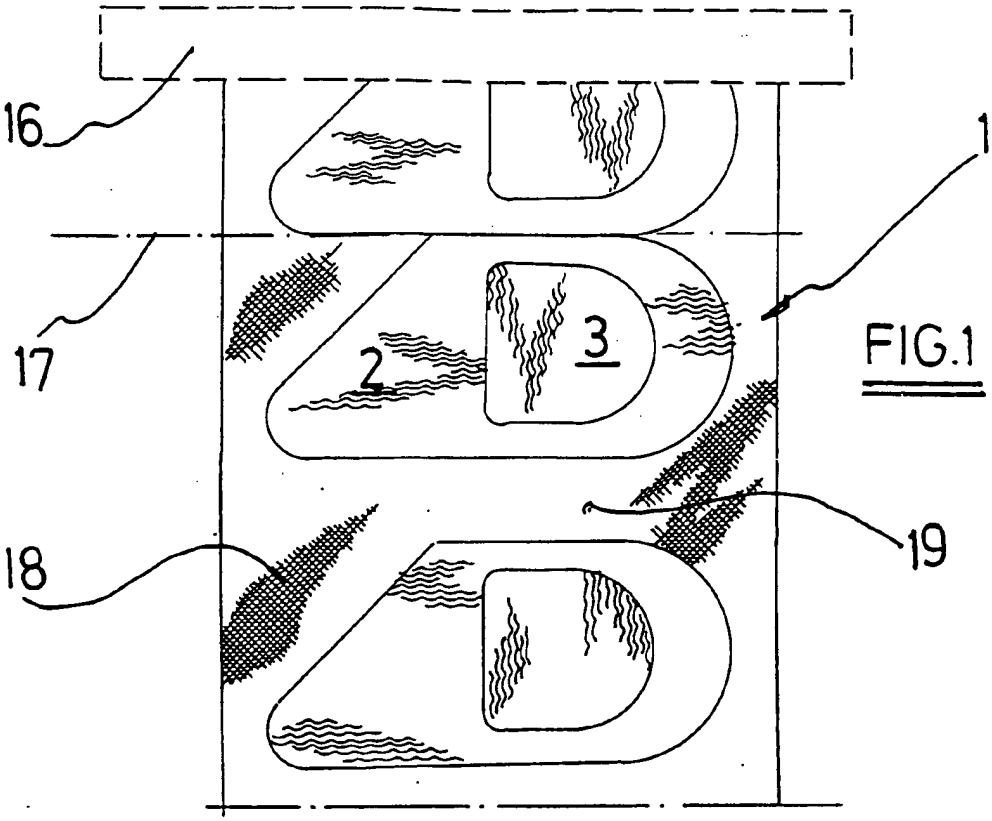


FIG.1

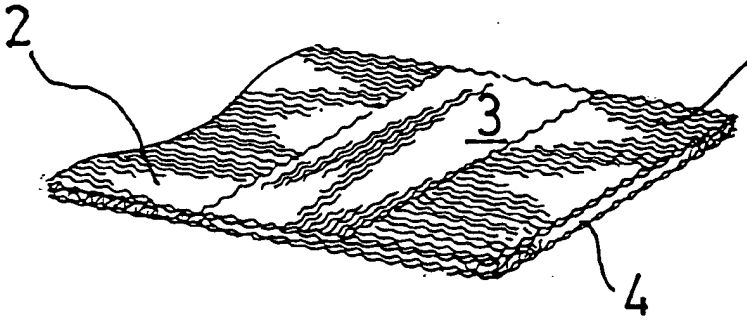


FIG.2

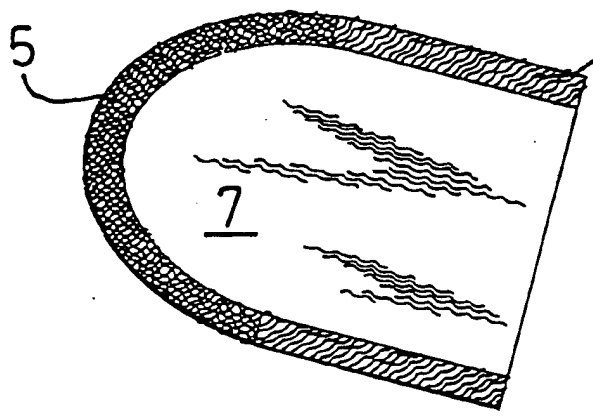


FIG.3

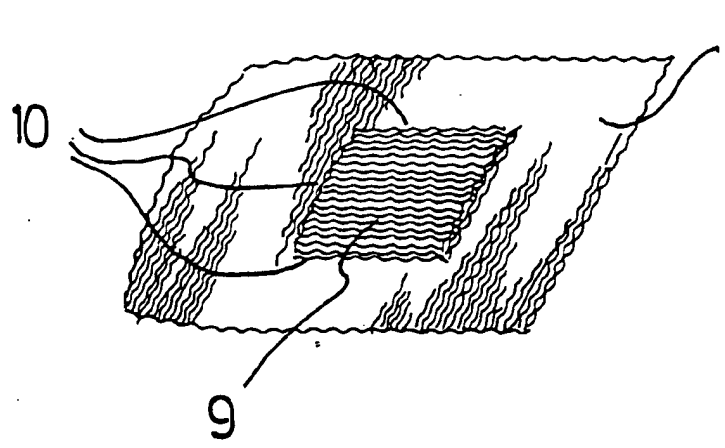


FIG. 4

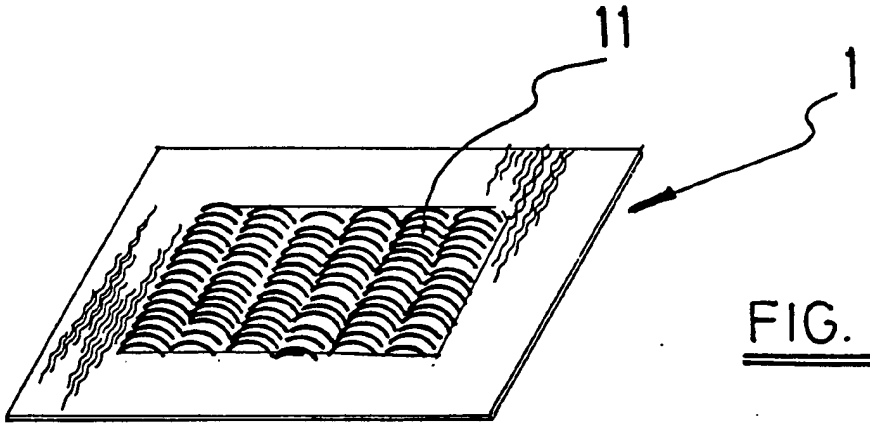


FIG. 5

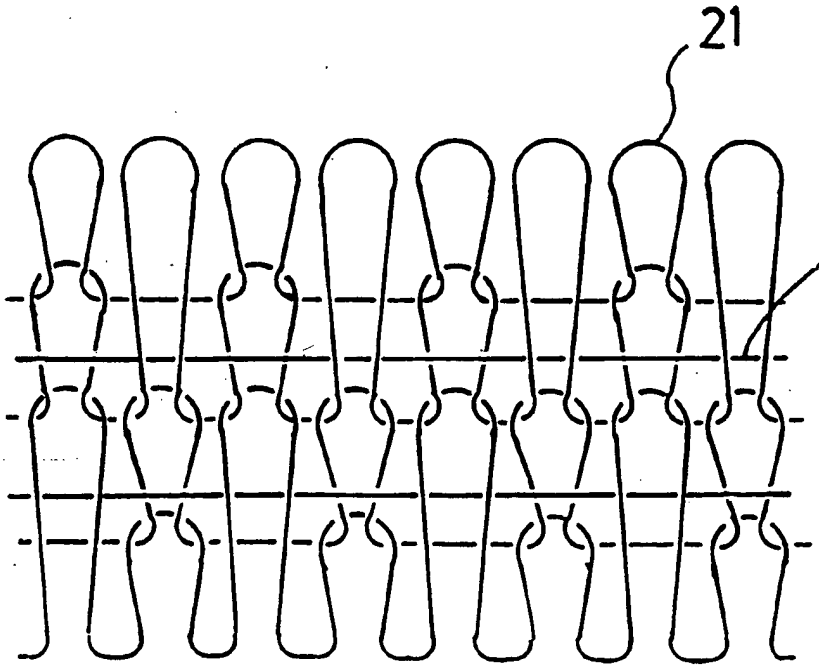


FIG. 6

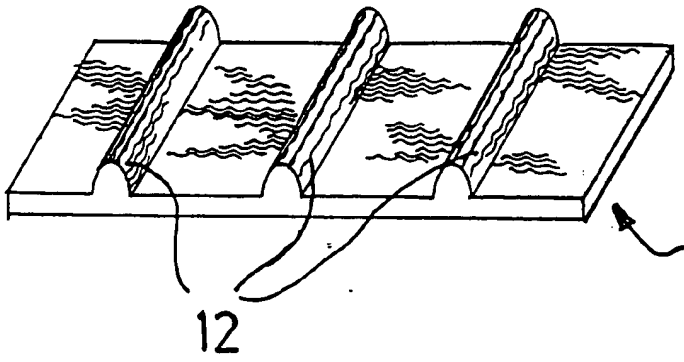


FIG. 7

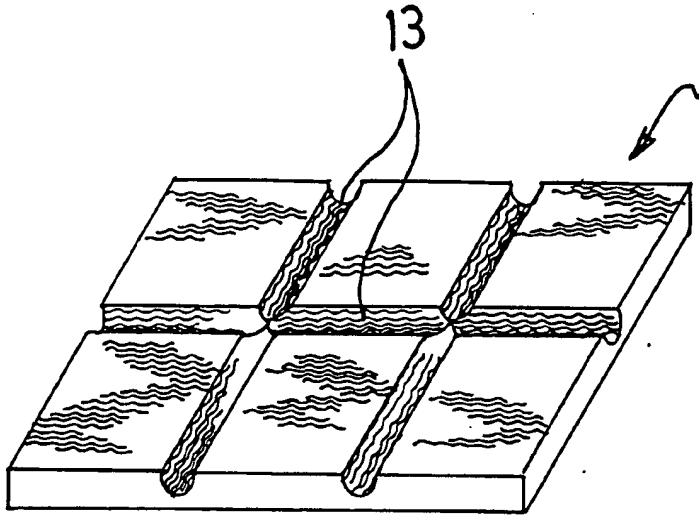


FIG. 8

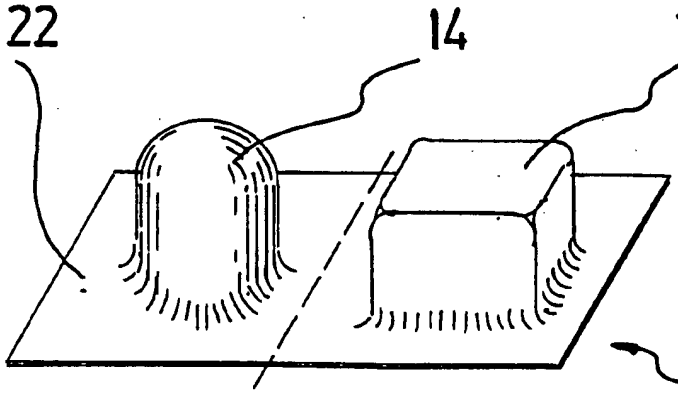


FIG. 9

FIG. 10

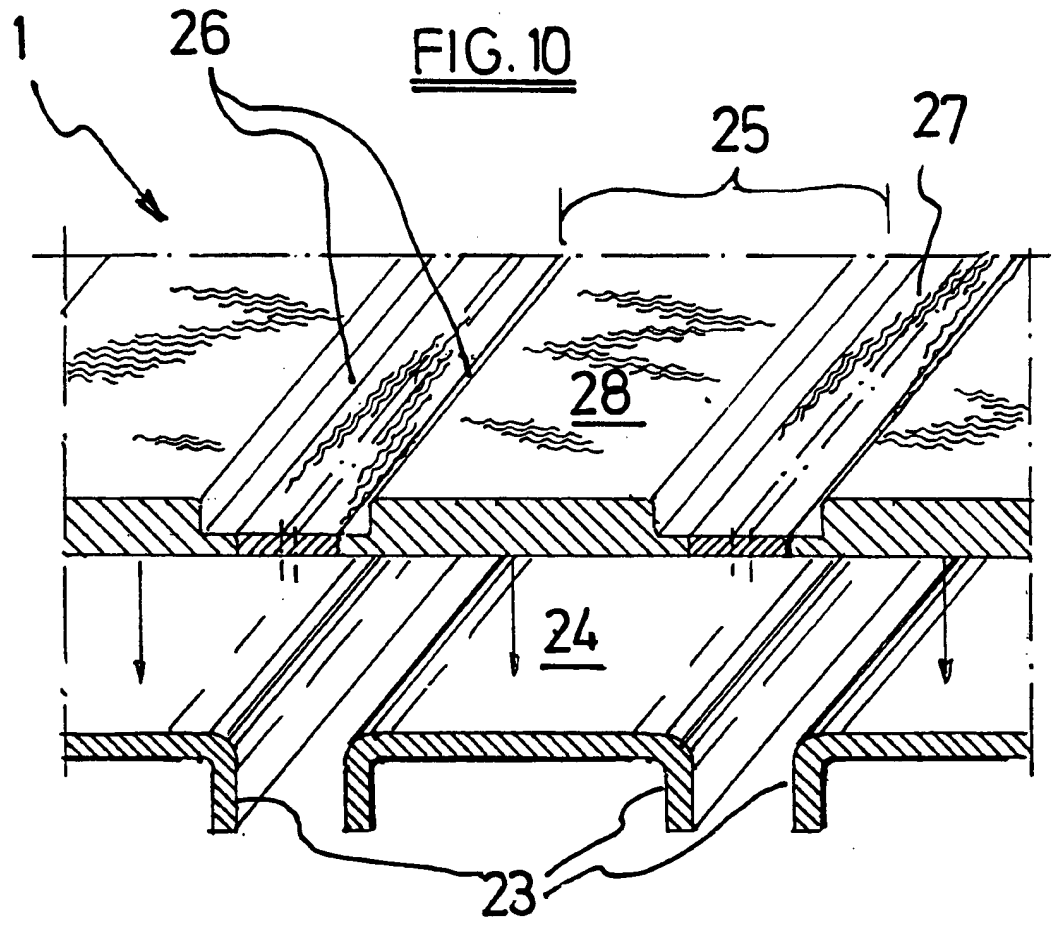
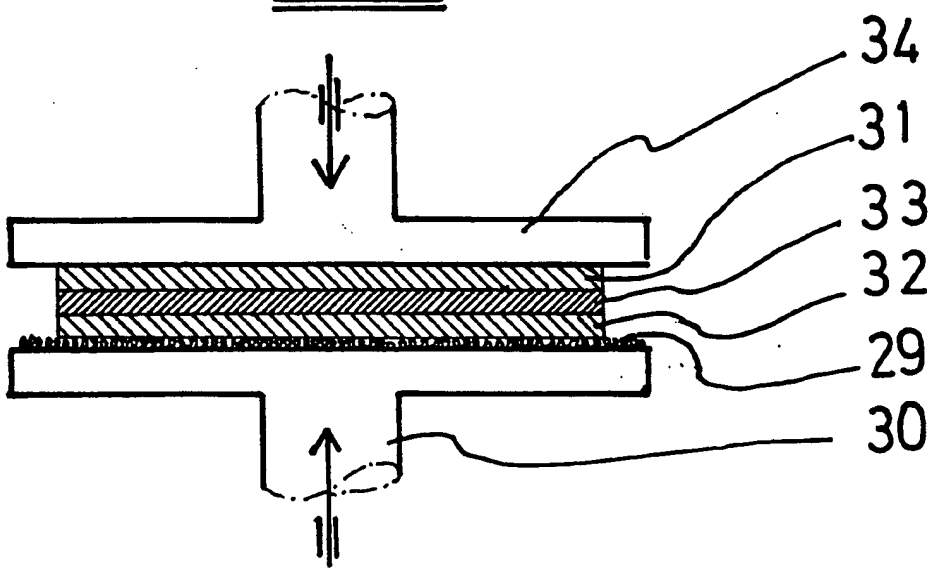


FIG. 11



INTERNATIONAL SEARCH REPORT

International Application No PCT/BE 93/00044

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 C03B23/023; D04B1/00; D04B1/10; D03D15/12
D03D15/00; C03B23/03

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	C03B ; D04B ; D03D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
A	EP,A,0 477 785 (NIPPON SEISEN CO.) 1 April 1992 see the whole document	1
A	EP,A,0 438 342 (SAINT-GOBAIN VITRAGE INTERNATIONAL) 24 July 1991 see the whole document	1
A	EP,A,0 319 298 (MINNESOTA MINING AND MANUFACTURING COMPANY) 7 June 1989 see the whole document	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
07 SEPTEMBER 1993	04. 10. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	VAN DEN BOSSCHE W.

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0477785	01-04-92	None		
EP-A-0438342	24-07-91	FR-A-	2657342	26-07-91
		JP-A-	4357130	10-12-92
		US-A-	5125947	30-06-92
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